DECIDUOUS LEAVES.

JOHN H. SCHAFFNER.

Plants have alternating periods of rest and activity. In our latitude these periods usually correspond to the alternating conditions of day and night and to the seasons of the year. The active growing period usually occurs in the summer or the rainy season and the inactive one corresponds to the cold or dry season. Where the seasons are so marked as in Ohio one takes it as quite natural that there should be a resting period in the winter. But many plants pass into a period of rest even if growing in an environment perennially favorable. Thus it is very common for complete defoliation to take place in many plants of the tropics. It is said that there are nearly two hundred species in Ceylon which become leafless at different times of the year. The statement is made that there is not a month when all the trees are in full leaf. It is evident, therefore, that in many cases the period of rest and the deciduous habit are independent of climatic conditions no difference how the character was originally acquired. In our own plants the influence of cold is no doubt predominant. The injuries of winter are not only due to the direct effect of cold upon the protoplasm, but also to the loss of water. With the approach of autumn, the chilled roots are unable to supply the necessary amount of water for the transpiration going on above; consequently there is a great advantage in reducing the transpiration surface by shedding the leaves. Thus we might say that the casting of the leaves is an adjustment to a more limited water supply. Plants may of course go into a period of rest without shedding their leaves, as in our common Conifers. In most cases, however, there is a great change in the body of the plant or some of its parts to prepare for the severe conditions. The annuals die completely and the only resting period is in the seed. The biennials usually grow but little after the cold becomes severe. The greater number of geophilous plants die to the ground. The woody plants and a few herbs have mostly learned to endure the

winter by specially developed stems, the leaf which represents the active transpiring and food manufacturing organ being usually shed.

The methods by which the leaves are separated from the stem are various. Some plants like the Hemlock shed them after they are several years old. Others like the Pines get rid of the foliage leaves by pruning off dwarf branches of a certain age. Some like the Bald Cypress and Tamarix drop the dwarf branches and smaller twigs with the leaves at the end of each growing season; so the plant has no leaves in the winter. But the common way is for the leaves alone to be separated from the branches. A cleavage plane is formed usually at the base of the petiole and the leaf then falls away. The separation layer is gradually developed between the vascular bundles and epidermis, and finally, when the cleavage is nearly complete the merest puff of wind will break the woody strands and carry the leaf away.

The casting of the leaf, however, is not a sudden process but preparatory changes are going on in its tissues for some time before it is detached. In many cases anthocyan and other coloring matters are developed to protect the chlorophyll and protoplasm while the food material is being transferred to the stem.

After the cleavage plane is formed a heavy frost will help to break away the fragile woody strands which still hold the leaf in place. This is very apparent in such trees like the White Mulberry, which may put off its entire leaf dress in a single day after a frosty autumn night. There is much difference in the time of casting the leaf. The Ohio Buckeye, Juneberry, Walnuts, and Hickories are among the first to shed their leaves. The Cottonwood and Chestnut Oak shed their leaves very gradually; and some of the Oaks are among the last of the trees to be bare. The Shingle Oak drops few leaves before late in the winter, although they dry off, and it is not completely denuded until about the first of April.

It is interesting to note the several ways in which the cleavage planes are produced. In plants with simple leaves a separation layer is more commonly formed at the base of the petiole very close to the stem, as in the Elm, Maple, Oak, and Catalpa. In some, however, two cleavage planes are produced, one at the base of the petiole and the other at the outer end just at the base of the blade. This is strikingly shown in Ampelopsis tricuspidata and A. cordata. The blade drops off some time before the petiole, so that in certain years a vine of A. tricuspidata may shed nearly all of its blades before the petioles begin to fall making a rather unique appearance. The same adaptation is present in the various species of Grape. There is probably considerable advantage to the plant in such an arrangement, for the food in the large petiole, which is in much less danger of freezing than the blade, may

thus have a longer time to be withdrawn into the stem. In the Catalpa, for instance, the blades often freeze and dry up in the fall while the petioles are still green and active. It would evidently be better if the useless blade were cut off by a cleavage plane so as not to hinder the work of the petiole.

In compound leaves the leaflets are usually shed singly. The leaflets of such palmate leaves as in the Virginia Creeper and the various Buckeyes are cut off some time before the petiole. Pinnately compound leaves have various peculiarities. In such forms as Rhus glabra the leaflets are separated by cleavage planes but no transverse cleavage joints are formed in the main rachis which persists for some time. In other forms, like in Fraxinus quadrangulata and Staphylea, not only are the leaflets cut off by cleavage planes but there is a series of cleavage joints formed in the rachis at the insertion of each pair of leaflets and thus the main rachis of the leaf drops off piece by piece. Decompound leaves often form an elaborate system of separation layers. A good example of this is shown in the leaf of the Honey Locust. First the numerous leaflets drop off, the main rachis and the side branchlets remaining on the tree for some time. Next the side branchlets begin to fall, and finally the whole rachis is separated. One may well ask the meaning of such an elaborate system of cleavage planes when one amputation at the base of the petiole would be sufficient. There is no doubt but that the green rachis and petiole may continue, to a limited extent at least, the process of photosynthesis; and as stated above, by means of a gradual cutting away of the large leaf surface the more exposed parts are removed first and there is a better opportunity for the withdrawal of the food present into the stem.

A very interesting condition is present in the Green Briers. The leaf of Smilax hispida has two tendrils near the base of the petiole and these, of course, hold the plant to its support. Evidently if the leaf were shed in the usual way the whole vine would fall to the gound in the winter. There is a more or less perfect brittle layer formed in the petiole just a little beyond the two tendrils where the leaf finally breaks off, leaving the petiole base with the tendrils intact. Most of the leaves hang on until after December 1, though usually frozen before this time. The development of a brittle layer in the petiole of this plant seems to be quite a modern adaptation. Smilax glauca, S. rotundafolia, and S. bona-nox show the same peculiarity. The genus Rubus represents another group of plants which shed their leaves by a break in the petiole, leaving the base on the stem. In this case there are no tendrils and the only apparent advantage to the plant is the protection of the bud or tender part in the axil of the leaf. The adaptation, however, may have no other significance than one of the possible ways in which the plant was able to get rid of its

leaves. Among the species which show this peculiarity well are Rubus odoratus, R. strigosus, R. occidentalis, R. nigrobaccus, and R. invisus. In the common Mock Orange, Philadelphus coronarius, the cleavage plane is formed a little above the base of the petiole which remains as a protection to the axillary bud.

There are certain plants which have the habit of covering their axillary buds with the base of the petiole. The Sycamore, Platanus occidentalis, presents a very perfect example of this adaptation. The reason for such a peculiarity is not easy to see. It may be for protection, or again as in Rhus glabra it may prevent the development of too many lateral buds into branches. But there may be no special advantage whatever. It may be a mere incident to the adjustment of the leaf to the surrounding tissues. Other plants which cover their lateral buds are Cladrastis lutea, Rhus hirta, R. copallina, Acer negundo, Ptelea trifoliata, Gleditsia triacanthos, Robinia pseudacacia, R. viscosa, and R. hispida. In Gleditsia and Robinia there are a number of superposed buds only part of which may be covered.

The undersigned wishes to make a census by counties of the pteridophytes of Ohio. To further this aim, the cooperation of every science teacher and fern student is asked. Specimens with full and exact data are desired and will be identified or referred to some competent authority. Unless otherwise provided for all duplicate specimens will be sent to state herbarium, O. S. U. Address June 15th to August 10th, University of Wooster, O.

LEWIS S. HOPKINS, *Troy, Ohio.*

Date of Pnblication of May Number, May 1, 1904.